Volume 29 May, 1943 *Number 5*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Earth Moving and
Open-Pit Iron-Ore Mining

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Earth Moving and Open-Pit Iron-Ore Mining

EARTH-moving in volume became essential to the march of progress when the automobile and motor truck developed to such an extent as to require our modern network of highways. Then hills were moved, valleys filled. The railroad surveyor, of course, had planned for good use of earth-moving machinery before we became so motor-minded; his, too, was a job of planning huge volumes of cut and back-fill. At about the same time the open-pit miner was using similar machinery for stripping the overburden from the vast iron-ore deposits in the Lake Superior region, and for subsequently loading the ore into cars or trucks for transfer to the concentrators and blast furnaces. The Ranges furnished the proving ground for some of the heaviest duty earth-moving machinery.

When the war program required speeded-up handling of these materials the machinery people were quite ready. Power shovels of greater tonnage capacity, belt conveyors of unprecedented length, electric motor and internal combustion engine power plants all contributed when war became a war of steel.

Open-pit mining probably resulted from Man's ability to shovel earth, and his need for the outcropping metal he observed. Open-pit mining preceded any other method of removing metals from the earth. Removal of surface material was practicable by hand labor, so when the age of metal followed the age of stone it was only natural that outcroppings of copper and iron were investigated by the progressive prehistoric man.

Volume production only became possible with the machine age, and the development of the power shovel. Then the vast iron-ore deposits of the Mesabi and other ranges on Lake Superior could be worked economically. Naturally open-pit mining also was extended to areas where flat-lying ore deposits of other metals, notably copper, were present. But it is still most actively applied to iron ores, with the result that most of the iron ore in the United States is mined in this manner.

Maintenance now is a more important problem than ever before. It had always been important since no machinery can undergo the rigors of outdoor operation in all sorts of weather and stand up indefinitely. Some parts will be bound to fail if neglected. As a result, maintenance is essential to correct the effects of wear.

The extent to which wear will occur depends largely upon the protection afforded by lubrication. Obviously if lubrication is effective maintenance costs will be reduced, but even of more importance today, machinery will be kept in service.

THE LUBRICANTS INVOLVED

Just as earth moving and open-pit mining require rugged machinery, so does this machinery, in turn, require rugged lubricants. The basic mechanisms are denoted on the chart on the inside back cover. Study of this chart will show that many of the machine parts, though subject to widely varying service, are quite similar as to their structural and lubrication requirements, viz., electric-motor bearings or gears.

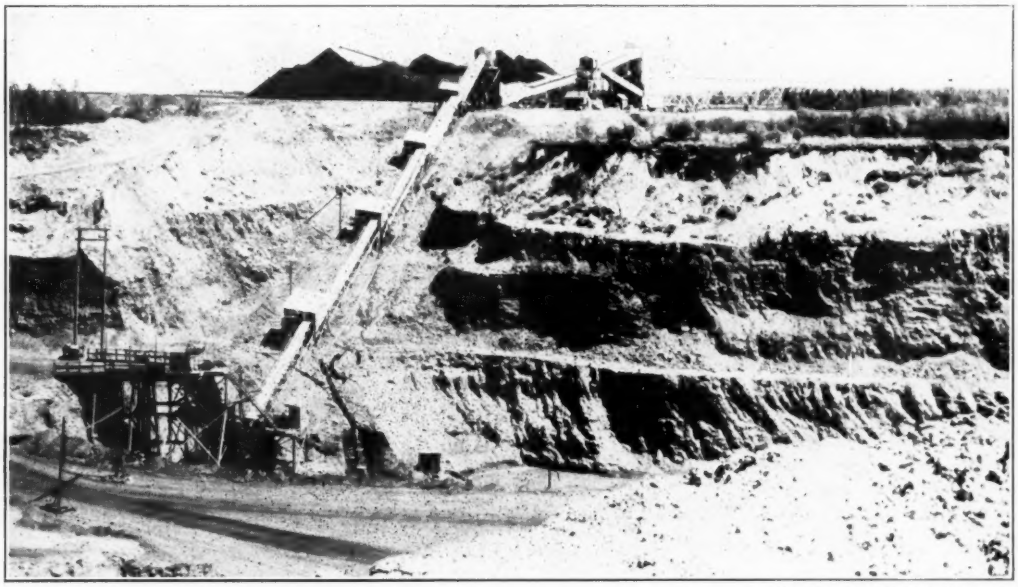
This makes it practicable to consider the lubrication of machinery such as the power shovel from the viewpoint of the characteristics the lubricants must possess based on what they must do. As the aforesaid chart suggests, we will be concerned primarily with

Electric motor bearing oils and greases
Conveyor roller bearing grease
Track-roll lubricants
Hydraulic oils
Diesel and gasoline engine oils
Heavy duty bearing lubricants
Car wheel journal bearing oils
Wire rope lubricants
Gear lubricants
Steam cylinder oils.

GENERAL PROCEDURE IN OPEN-PIT MINING

The technique of power shovel operation in open-pit mining requires handling of the earth and ore by the bench method, the shovels work on one or more levels according to the nature of the material to be handled. As this is dug away it is loaded into cars, trucks or onto conveyors for removal out of the pit.

After the shovel has done its work and exposed a sufficient area of the ore-bed, blasting or shooting is sometimes necessary to break up ore to facilitate handling. This means that holes must be drilled for the powder charges; involving another type of equipment which requires careful maintenance, the churn drill.



Courtesy of Link-Belt Company

Fig. 1—Typical scene on the Range, showing a Link-Belt conveyor system for handling iron ore from mine bottoms to the ore-preparation plant at the top of the ore body.

MOTOR BEARINGS

Electric motor power is widely preferred in modern earth moving or open-pit mining operations where electric lines are available. Either alternating or direct current can be used, the latter being more flexible. Some half a dozen motors are used on the electric-powered shovel, for operation of the crowd, swing and hoist mechanisms. The hoist motors also furnish the power to move the shovel.

Power shovel motors may be equipped with ring-oiled bearings, or heavy-duty ball or roller bearings. As the motors are probably the most sensitive mechanisms on the property, their lubrication rightfully is entitled to primary consideration. Neither a ring-oiled nor a ball or roller bearing requires much lubricant, but what it does get must be suited to the operating conditions, and sparingly applied.

Excessive use of oil or grease can cause considerable expense due to burned out windings.

So motor bearings are carefully designed and usually well sealed. Over-zealous use of a pressure grease gun can ruin many types of ball or roller bearing seals due to the pressure created by expansion of the grease.

Ring-oiler Requirements

The ring oiler on a heavy-duty motor bearing is an automatic oil circulating device of the most simple type. It stands hard service, but can become inoperative due to contaminated or unsuitable oil, for the ring must hang freely on the shaft if it is to turn and carry oil to the top. Any gumming or accumulated foreign matter in the ring slot may interfere with this movement. If the ring becomes stuck, it may lead to starved lubrication and a bearing renewal job if not corrected. This makes it advisable to flush and refill all ring-oiled bearings every one or two months according to how dusty the operating conditions may be.

Highly refined straight mineral oils are recommended for ring oilers—oils which are resistant to oxidation and gumming. Normally a viscosity range of from 150 to 500 seconds Saybolt Universal at 100 degrees Fahr. is desirable. It is especially advisable to specify low pour test so that the oil will not become too sluggish in cold weather to keep the rings from turning freely.

Motor Ball or Roller Bearings

Grease lubrication prevails on these bearings. There is considerable responsibility attached to the selection of grease for a ball or roller bearing as we are dealing with a precision mechanism which can be damaged severely by corrosion or loss of seal. Accordingly a ball or roller bearing grease must be primarily a specialty lubricant, composed of highest quality ingredients and designed to resist breakdown when subjected to oxidizing conditions. Such a product will also resist separation of the oil. All through the course of manufacture the petroleum technologist must bear these contingencies in mind, for accumulations of non-lubricating material, or development of acidity or gumming can cause balls or rollers to stick, corrode or become pitted. If any of these occur costly renewal may be necessary, with perhaps considerable loss of time.

The operator must also rely upon the petroleum technologist to manufacture ball or roller bearing greases to a suitable degree of workability. This property is indicated by the consistency or penetration; it also indicates the texture. For example, lime base chassis grease will be of a short fibery or buttery nature, whereas a sodium base or mixed base roller or ball bearing grease will be of a more fibrous or spongy texture. The consistency of the grease, however, is controlled mainly by the method of manufacture and the amount and viscosity of the oil used.

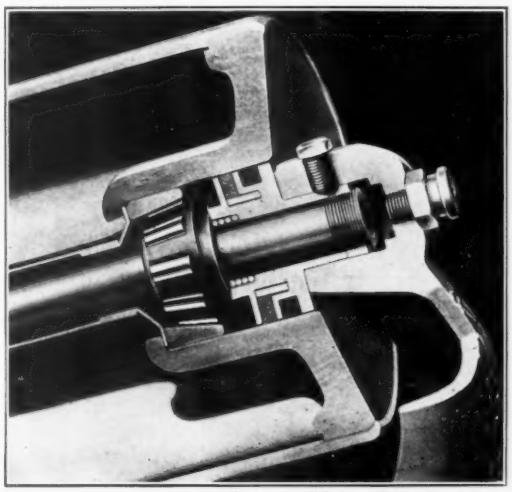
Westinghouse Electric & Manufacturing Company in their booklet on Mine Locomotive Maintenance give the following typical analysis for a ball and roller bearing grease, viz.:

Soap	10% Soda and 1.9% Calcium average
Mineral Oil Average	87.3%
Viscosity Mineral Oil	300 Sec. @ 100 degrees Fahr.
Penetration ASTM	265 to 295 both worked and unworked
Melting Point	316 degrees Fahr.
H_2O	.1
Free Fatty Acid	.31

TRACK ROLLS AND CONVEYOR BEARINGS

Plain bearings and roller bearings are used on track rolls, and the long runs of belt conveyors which have come into use on certain iron-ore mining properties.

The track roll bearings require a considerable volume of lubricant, as application twice a day is usually recommended when the equipment is operating. The conditions of operation are more severe than on the machine floor above, as the tracks are exposed continually to water-



Courtesy of Robins Conveying Belt Co.

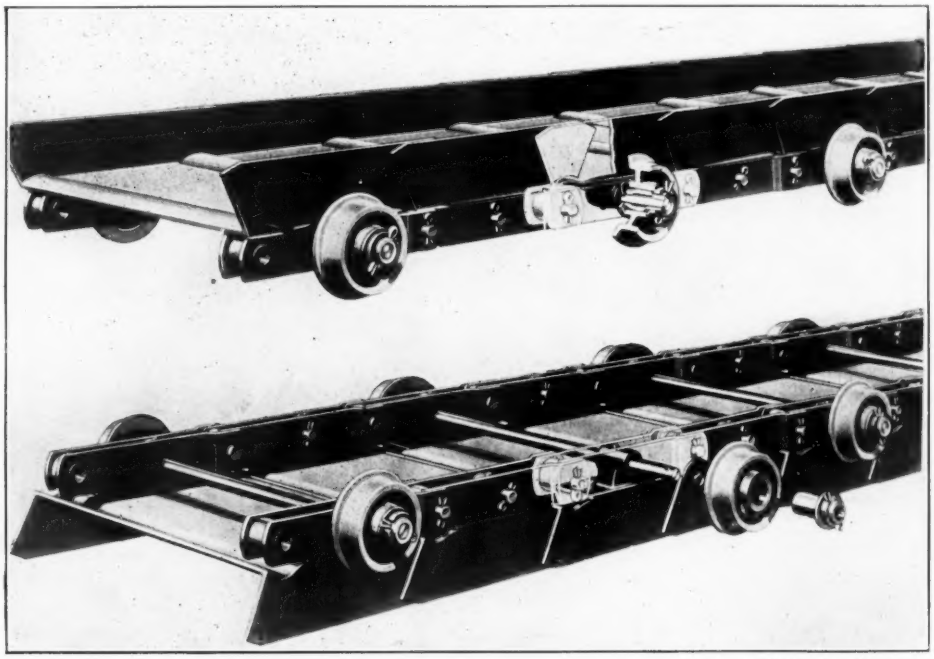
Fig. 2—Details of a Robins Conveyor belt roller, showing bearing and lubrication fitting.

wash, mud or dust. The sleeve-type track end bearings must be given particularly careful attention due to the shock loads to which they are subjected. The most satisfactory lubricant for these bearings in warm weather is a

grease containing a heavy mineral oil. In cold weather a straight mineral oil, or a grease of low temperature characteristics is most suitable.

Belt conveyor roll bearings may number into the hundreds. These bearings are specifically designed and sealed to prevent entry of non-lubricating or abrasive materials. As a result they require re-lubrication less frequently, usually once a month in normal service when the seals are in good condition.

Conveyor roll lubrication is unique in that the center roll bearings are lubricated usually from the same fitting as the side rolls. This means that the grease must travel a distance of from two to three feet before it becomes effective. As it is exposed to weather temperatures in the lubricating piping, obviously it must be readily handled at low temperatures. Here again the property of consistency is of assistance in enabling the operator and lubricating engineer to predict how any particular grease will handle in cold weather, and to obtain a low torque product which will be conducive to low power consumption. The range of consistency or penetration indicated in the foregoing table of tests normally will be satisfactory.



Courtesy of Chain Belt Company

Fig. 3—A Rex leak-proof apron conveyor showing roller assembly and lubrication features.

THE CHURN DRILL

The modern churn drill is so designed that it requires only reasonable attention as regards operation, care and maintenance. The selection and proper application of lubricants to reduce wear and maintenance, however, is most necessary.

The power may be applied through an electric motor or an internal combustion engine. Motor bearings may be grease or oil lubricated. The modern ball or roller bearing generally requires grease; the ring oiler naturally should be oiled. The general nature of these types of lubrication has already been mentioned.

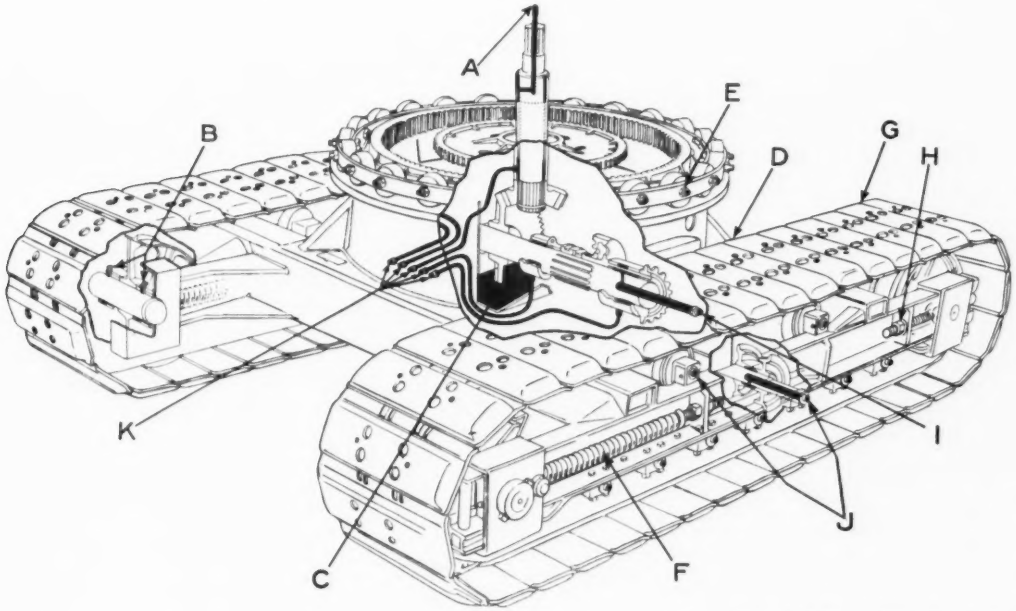
For the lubrication of internal combustion engines use the S.A.E. grade of motor oil specified by the manufacturer. This same oil can be used for enclosed reduction gears. All crankcases and gear cases should be drained at intervals of from 60 to 100 hours to remove any ore dust or metallic particles that may have collected.

Open gears and cables should be lubricated once or twice a week with a lubricant suited to the operating temperatures. On gears the best results will be obtained from a grade that requires some heating to allow brushing. For normal summer temperatures, it is customary to use a fairly heavy product; as temperatures drop, lighter grades are advisable. By handling in this manner most effective lubrication will be obtained with the least amount of lubricant.

Where anti-friction bearings are employed

on jack shafts, lubricate about once or twice per week depending on the service. Sleeve-type bearings should be lubricated sparingly once each shift. The operator must always be sure to lubricate spudding and bull-reel pinion

One should never judge such an oil by its viscosity alone. That characteristic is only a measure of the relative fluidity. Of far more importance is the chemical stability as indicated by the resistance the oil will show to



Courtesy of Harnischfeger Corporation

Fig. 4—Lubrication chart for a P & H excavator. *A* is the grease lubricated center top gudgeon bearing. *B*, the crawler drive and idler shafts, grease lubricated. *C*, the propel gear case; fill to indicated level with high quality transmission lubricant. *D*, the drive chain idler sprocket, greased. *E*, the live roller circle, greased every shift. *F*, the crawler tension springs. *G*, the drive chains, oiled according to nature of work. *H*, the sprocket adjustment bolts. *I*, the brake drum bushings, greased. *J*, the track rollers, greased every shift when digging. See the builder's chart for further details.

fittings, shifter collars, crown-sheave bearings, sandline-sheave bearings and guide-pin bushing fittings at the top of the derrick. These too often are neglected because of their location. Graphite bushings in the metal separators in the derrick head should not be lubricated, and lubricants should be kept off the rubber discs.

HYDRAULIC POWER MECHANISMS

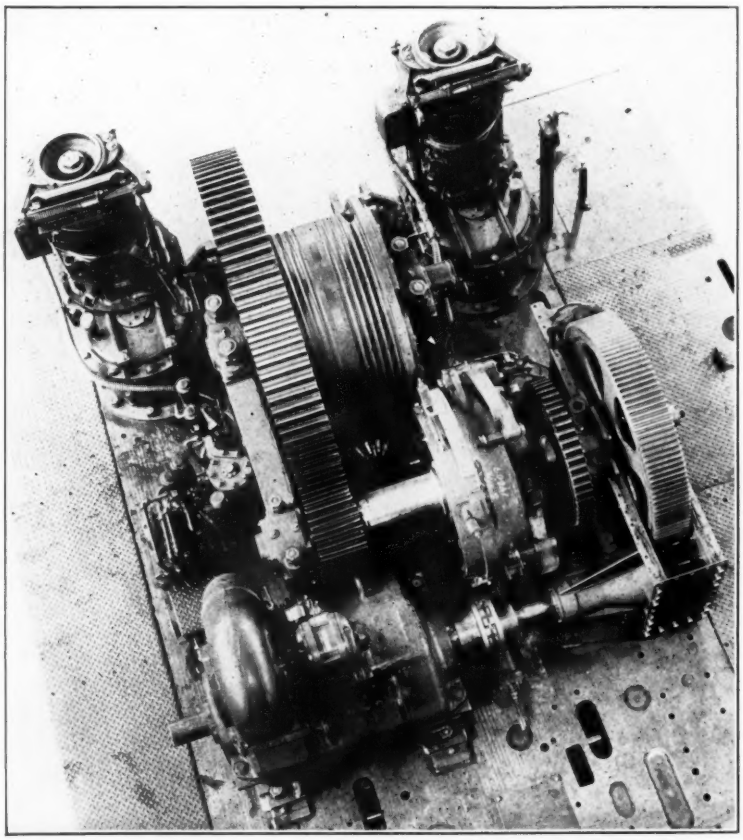
The use of hydraulic power in certain operations of earth moving and iron-ore mining machinery has been widely extended due to the flexibility which it lends to these operations. Hydraulic power concerns both the machine operator as well as the petroleum technologist, for the type of oil used in the system must be carefully selected. An unsuitable oil may eliminate many of the advantages of the system by sluggish action, slippage or gum formation in the braking or power transmission system. Accordingly, only oils of a very high degree of stability should be used. This characteristic is denoted by the manner and extent of refinement. It signifies resistance to oxidation.

oxidation. This is controlled by careful selection of the base stock, and regulation of the refinery procedure so as to remove the oxidizable hydrocarbon components from the oil. This assures that the finished oil will have maximum resistance to gum formation—a result of oxidation. The responsibility of the refinery extends also to packaging all oils for hydraulic power service so that cleanliness will be assured.

Since contamination can be equally as harmful to the hydraulic brake, pump, or motor mechanisms as is gumming, it is important also for the operator to handle his hydraulic oils just as carefully as he expects them to have been handled during manufacture. He also must remember that hydraulic oils become contaminated in service. For this reason flushing of the system should be done at periodic intervals according to the dust conditions prevailing.

To meet the operating conditions in the iron-ore ranges and on most other earth moving jobs, an hydraulic oil should be from 100 to 500 seconds Saybolt Universal viscosity at 100 degrees Fahr. according to the season and

operating temperature. By further specifying that the oil be of high stability and of refrigeration grade for cold weather operations, the customer is assured of the required quality.



Courtesy of Bucyrus-Erie Company

Fig. 5—Main deck machinery of the Bucyrus 120-B heavy-duty shovel. Simplicity of power transmission and controlled lubrication are important features.

AUTOMOTIVE-ENGINE-POWERED HAULAGE EQUIPMENT

During recent years ore handling in the pits has undergone a partial transition from rail haulage to truck-conveyors, truck-rail and other combinations of the motor truck or dumptor and belt conveyor. Flexibility and concentration of power have contributed to this transition.

The lubrication requirements of the internal combustion engine are exacting for design is intricate, clearances between moving parts are low and engine temperatures may vary widely.

Care, and attention to lubrication schedules are a part of good engine maintenance at any time. This becomes all the more necessary in open-pit mining where the operating conditions usually are far more severe than in road service. The designers of the heavy-duty engine have studied these conditions in perfecting their design in order to protect lubrication. The petroleum technologists have developed the rugged heavy-duty motor oils which keep them running.

Heavy-duty Motor Oils

It is very interesting to review the characteristics of these heavy-duty oils. They concern the operator quite as much as the management. Primarily all are interested in lubricating ability. This is measured best in terms of dependability and operating experience.

Incident to dependability we must consider the heat-resisting characteristics and seal maintenance. These involved the petroleum technologist, as they require that the oil be refined so that it will resist chemical breakdown under heat, that it will form the least amount of sludge or carbon, and that it form a sufficiently tough lubricating film to prevent blow-by of combustible gases, loss of compression or oil pumping past the rings.

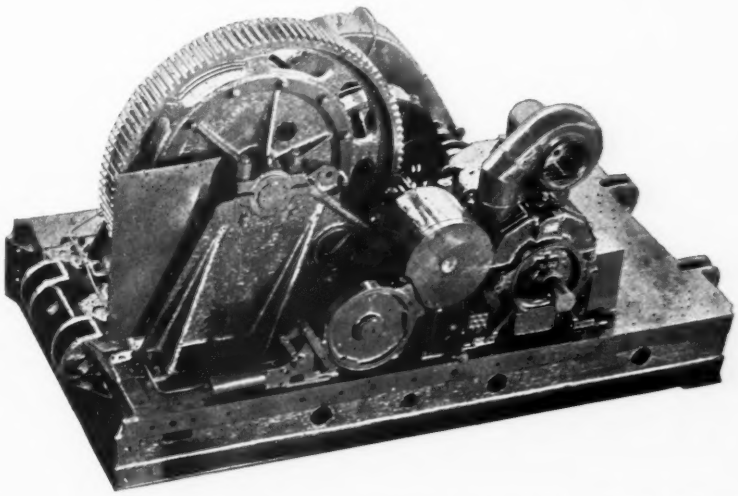
Of the measurable physical characteristics, the pour test and viscosity require most consideration. They denote the ability of the oil to function at the extreme ranges of the operating temperatures. The pour test should be sufficiently low to assure that the oil will flow readily at low cold starting temperatures. The viscosity should be sufficiently high to assure that the lubricating film will be adequate, yet not too heavy to cause excessive internal or molecular friction.

The Advantages of Centralized Lubrication

Use of the internal combustion engine enables centralized lubrication. In other words, the heavy-duty Diesel or gasoline engine is designed so that its cylinders and bearings can be lubricated by the same oil. This is a distinct advantage in mining areas where storage and handling of supplies may be often quite a problem. Centralized lubrication also assists in preventing contamination in service. During operation it is necessary only to watch the oil level at regular intervals; add make up as

necessary to take care of any loss, and *drain, flush and refill the crankcase at regular intervals* according to the type of service and engine builders recommendation.

The availability of the heavy-duty type of engine oils has become of special interest to the operator of open-pit mining machinery. Today such oils are making it possible to protect bearings and piston rings more effectually under speed-up operating conditions where ordinary motor oils would not be serviceable. It is important to remember that the type of bearing must be known when deciding upon the type of oil to use, for certain very serious consequences may result on some bearing metals if oils which may cause corrosion are used.



Courtesy of Bucyrus-Erie Company

Fig. 6—Hoist Machinery assembly on a Bucyrus 170-B shovel.

The copper-lead bearing has excellent bearing strength but it may become a serious offender if used where starved lubrication may develop, or with oils which may break down to form corrosive acids which would attack the lead content of the bearing.

Cadmium-silver and cadmium-silver-copper in turn may suffer likewise if very high bearing temperatures develop for any reason.

The tin-base and lead-base metals are not as susceptible to corrosion, but at the same time they are not as strong as the aforesaid alloys, nor can they withstand excessively high temperatures due to reduction in mechanical strength. Obviously the combination of high unit loads and elevated temperatures would affect the bearing life. Tin-base and lead-base metals, however, conform better to shaft irregularities, and also can absorb or imbed a certain amount of abrasive foreign material before it can have a chance to score the shaft surfaces.

Function of the Additive

These conditions required consideration of the additive type of oil. It is interesting to note just what this term includes.

Briefly, an additive is a material which is added to a heavy-duty engine oil to increase the oxidation-resistance and to impart detergency characteristics. By increasing the resistance to oxidation the formation of corrosive acids (which would be harmful to alloy bearings) is retarded. Detergency characteristics imparted to the oil by a suitable additive eliminate deposition of harmful sludges and varnishes by exerting a detergent action. Use of an additive type oil also helps to reduce ring sticking.

Certain additives also prevent accumulation of fuel soot and other types of non-lubricating matter in engine parts. Dispersion—that property which enables this—is strictly a colloidal action whereby the foreign matter is held in suspension in the oil; a dispersive oil does not necessarily exert any solvent action, so engine deposits are not removed to any great extent. Detergency provides this cleansing action. In an old engine an oil containing a detergent additive prevents redeposition of deposits. In a new or reconditioned engine detergency helps to prevent initial deposits.

An oil containing a dispersive type of additive can carry only so much dirt; after that, when it has become saturated, engine deposits may build up unless the oil is changed. Accordingly, engine builders recommendations as to frequency of oil change and crankcase cleaning should be carefully followed.

Engine Maintenance

In addition a regular maintenance schedule is advisable, to correct mechanical defects and make sure that engine deposits do not become excessive. On the presumption that a reasonable amount of wear of bearings and rings must be expected, it is of interest to consider some of the conditions which will contribute most actively to this wear, i.e., misalignment and dirt.

Misalignment

Lubrication of any bearing can best be main-

tained if the latter is properly aligned with respect to the other parts of the engine. Serious misalignment can reduce materially the bearing load-carrying capacity. The value of proper alignment is best illustrated by discussing the detriment of misalignment. Let us consider the causes. Chiefly they will include careless mechanical workmanship or accumulation of dirt between the bearing shell and connecting rod cap or crankcase saddle bore.

Preventing Dirty Bearings

Extraneous foreign matter—road dust to the mechanic—is the chief offender; it gets in through the breather or accidentally when make-up oil is added. Then it is circulated with the oil. Some precipitates in the oil sump, some is caught by the air cleaner and oil filter, but often there is still some left in suspension in the oil to be circulated through the lubricating system. Air cleaners should be serviced regularly as required by dust conditions.

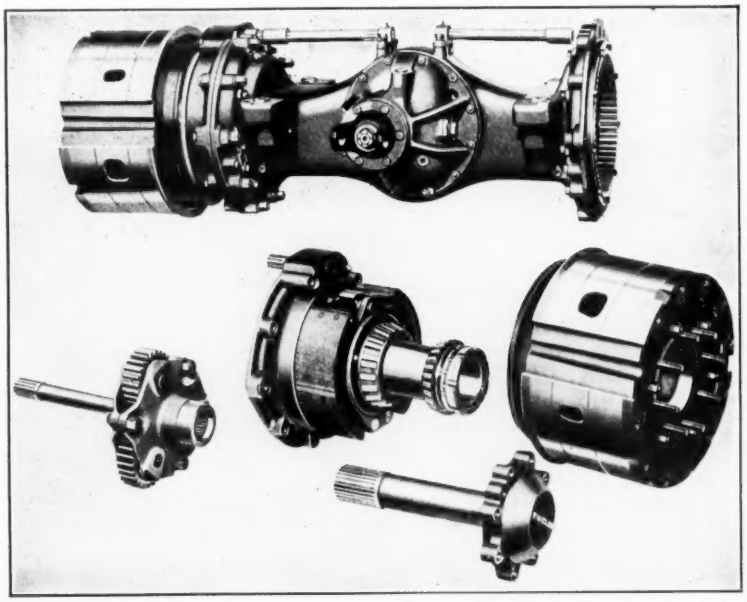
Depending upon the nature of the bearing metal, and stability of the oil, some of this foreign matter may be accumulated in the gum-like materials which may result when unsuitable motor oils are subjected to heat and oxidizing influences. Gradually piston ring spaces, oil grooves and bearing oil holes will become clogged, and a film of this dust-carrying gum will form over either or both the bearing and journal surface or cause the piston rings to stick. This will cause blow-by, cylinder lubrication will be impaired, bearing temperatures will rise, more oil will be oxidized, perhaps corrosive acids will attack the bearing metal, and finally some of the bearings may fail.

Before all this occurs, it is possible to minimize the combined effects of dust and oil breakdown by *frequently changing the oil and flushing the crankcase as already stated.* Under very arid or dusty conditions this might be advisable every sixty to one hundred hours. The oil used should be as high quality as possible.

Mechanical Misalignment

Other probable causes for misalignment involve carelessness in engine assembly. For example, unevenly set up bearing bolts, or a bowed crankshaft.

The torque wrench will correct the former. Unless the mechanic is expert, he should not rely on feel and touch to guide him as to how much to take up on the bolts. It is too easy to have one tighter than the other, which would cause the bearing to grip or bind the journal—the beginning of a state of misalignment.



Courtesy of The Euclid Road Machinery Co.

Fig. 7—Details of The Euclid double-reduction planetary-type truck drive axle.

Condition of Journal Surfaces

Another factor is the condition of the journal or pin surfaces. Any scoring or out-of-roundness is serious for it can affect the formation, maintenance and thickness of the oil film. Careful calibration of these surfaces is advisable when major over-haul is being done. Out-of-round surfaces can be rebuilt and then honed, lapped and re-finished to bring them again to a state of perfect roundness.

DIFFERENTIALS AND TRANSMISSIONS

Axle Design

Axle design is an important factor on ore handling equipment where tremendous loads must be applied. The double-reduction planetary-type drive axle is one of the significant developments which is facilitating truck operation today. See Fig. 7.

It is obvious that where a payload of some fifteen to thirty tons must be carried up steep grades under full power, the rear axle assembly is the heart of the power transmission assembly. This assembly is made complete by the use of

heavy-duty tapered roller bearings. Then, by completely enclosing the rear axle assembly in an oil-tight housing, bath lubrication becomes practicable, permitting the use of a quality

Courtesy of Koehring Company

Fig. 8—A Koehring dumptor truck at work on the Range.

extreme pressure lubricant which can meet the load conditions most effectually. Gear lubricants in this type of service should be drained, and the cases flushed and refilled every thousand hours.

Transmissions

In contrast with the differentials, the tooth loads on the transmission gears are considerably lower; this permits the use of a straight mineral gear lubricant of S.A.E. 90 or 140 grade according to the temperature.

Resistance to oxidation and foaming should be most carefully considered when selecting automotive gear lubricants.

Truck Wheel Bearings

Truck wheel roller bearings often may have to be lubricated under widely varying temperatures and operating conditions. On the Range in winter the atmospheric temperature may drop to —40 degrees Fahr. In contrast, in summer operation in southern climates the maximum hub temperature may exceed 250 degrees Fahr. Naturally, a satisfactory wheel bearing grease must be soft enough to furnish good lubrication at the lowest operating temperatures likely to be encountered and yet hard enough to prevent undue leakage at higher temperatures.

These intensive operating conditions require the production of wheel bearing lubricants to specifications which will conform to the expected temperatures. Sodium base greases are best adapted to these conditions and are superior for heavy-duty wheel bearing lubrication because they have sufficiently high melting points to insure against separation or breakdown when exposed to the highest operating temperatures likely to be encountered in the wheel hubs. To meet this requirement a wheel-bearing grease for normal service should have a maximum usable temperature of at least 250 degrees Fahr. For low-temperature conditions a softer grease is preferred. In either case the texture of the grease is a most important characteristic; if the texture is "right" there will be minimum possibility of leakage regardless of the temperature.

A medium-heavy viscosity straight mineral oil is a factor in this regard, the percentage of sodium base material varying according to the

oil viscosity and the desired consistency. Texture is a function of the ingredients and method of manufacture.

Truck Chassis Lubrication

A truck-chassis lubricant must conform to four important requirements:

1. Have lasting ability or long life.
2. Be water resistant
3. Be adhesive, and
4. Form a protective seal to prevent entry of contaminating foreign matter.

Four basic types of greases are available for chassis lubrication, viz.;—calcium, sodium, aluminum or mixed base. The general range in consistency will be from semi-fluid to a stringy plastic.

Sodium base greases are preferred; they have the highest melting point of any of the above. Furthermore, they have the advantage of good stability and will not separate at temperatures in excess of some 250 degrees Fahr. While these greases are emulsifiable to some extent in warm water, solubility is negligible where the method of preparation is carefully controlled with respect to the viscosity of the mineral oil and amount of compound used. A sodium base grease of this type is unusually resistant to road wash and possessed of sufficient adhesiveness to form an effective seal around the chassis parts to exclude water, dust or sand; and to resist squeezing out and throw-off under road shocks and loads.

Courtesy of American Steel & Wire Co., U. S. Steel Corporation subsidiary

Fig. 9—Electric shovel operation requires heavy-duty wire rope; likewise this rope requires very careful lubrication.

WIRE ROPE PROTECTION BY LUBRICATION

Wire rope is necessary for manipulation of the shovel dipper, or for swinging and locating the drag-line scraper. So there is a considerable volume of wire rope to be cared for and lubricated. It gets a certain amount of lubrication when the strands are laid up as the core is saturated with a specially prepared wire rope compound. As the rope passes over sheaves or drums, however, the core lubricant tends to squeeze out. This lubricates the inner surfaces of the strands which are in constant frictional contact, but ultimately the supply becomes exhausted. Hence the necessity for renewal of lubrication at regular intervals. It is interesting to note what may happen if the rope is run dry.

The same type of friction is developed between the strands of a wire rope as between a bearing and its companion shaft. If the strands are not well lubricated abnormal wear develops, then the load-carrying capacity will be reduced and the power consumed in operation will be increased. A suitably prepared wire rope lubricant will penetrate to the innermost strands and core of the rope. At the same time if it is sufficiently adhesive and viscous it will resist being prematurely squeezed out or washed off by rain or sleet. A wire rope lubricant also must not cake, gum, or ball up, especially if contaminated with an excess of dust, dirt or metallic particles. Furthermore, it must not thin down to excess when exposed to summer temperatures.

Viscosity, the Guiding Characteristic

This involves the relative fluidity of the product. So viscosity is the guiding physical

characteristic to be considered at the time of purchasing. Viscosity, however, is far from being the chief guide as to the ultimate suitability of a wire rope lubricant. How the product will function, penetrate and stick under actual operating conditions, is of far more importance.

The viscosity is decided upon according to the operating temperatures that may be involved, and the possibility of the presence of an excess of water. Normally it should range from 500 to 1000 seconds Saybolt Universal at 210 degrees Fahr. The heavier grade is advisable where there might be possibility of thinning down to the extent of dripping off to perhaps result in lack of lubrication. This would hold for warm weather service. In cold weather a thinner product should be used.

Straight mineral petroleum products free from fillers or any thickening material are best suited for wire rope lubrication. Accordingly the viscosity should be an inherent property of the lubricant, not an artificial characteristic developed by materials of questionable lubricating value.

Complete Coverage Always Essential

The rope strands are protected most positively when covered completely by the lubricant. In cold weather this may require heating or warming prior to application of the lubricant. Penetration is the secret of effective lubrication of the internal strands of the rope.

GEARS USUALLY EXPOSED

Power transmission and speed reduction gears on power shovels and drag lines are usually exposed, though some may be fairly well housed. Accordingly there is every possibility of dust and dirt contamination of gear lubricants to increase the tooth surface wear and alter the pitch line. Pressure is also a factor. As a general rule tooth pressures will be comparatively high, due to the small areas of contact.

The direction of application of the load is constantly changing inasmuch as tooth pressures change constantly as opposing teeth mesh with each other. As long as rolling motion predominates, the effect on the structure of the teeth will not be serious. When wear occurs, however, there will be a tendency for increased sliding motion between the teeth. This can become cumulative, leading to more and more wear unless it is checked in the beginning by effective lubrication. The extreme pressure type of lubricant is excellent insurance against excessive tooth wear.

A gear lubricant must possess adequate oiliness to keep friction within an allowable range. This characteristic is dependent upon the viscosity and the ability of the lubricant to adhere to the teeth and resist the operating pressure. Temperature also will have some effect although in the normal operation of digging machinery, gears will function at atmospheric temperature. As a result, there will be but little possibility of abnormal heat causing extreme reduction in the viscosity of the gear lubricant.

Courtesy of The Marion Steam Shovel Co.

Fig. 10—Showing the crowding machinery and knee action on a Marion shovel.

Low Temperatures Require Most Consideration

Low service temperature, however, may have a far more serious effect upon a gear lubricant. Some types of lubricants will have a tendency to congeal to such an extent as to become brittle and crack. With a properly refined product of seasonal grade, however, there should be little danger of this occurring. Good ductility at

low temperatures is a characteristic of straight mineral lubricants.

The average range in viscosity for service on exposed gears will vary from approximately 200 to 2000 seconds Saybolt at 210 degrees Fahr., the higher viscosity is more nearly right to meet the usual requirements in open-pit mining areas in warm weather; in the winter, naturally, the lubricant must be lower in viscosity to facilitate application.

STEAM POWER

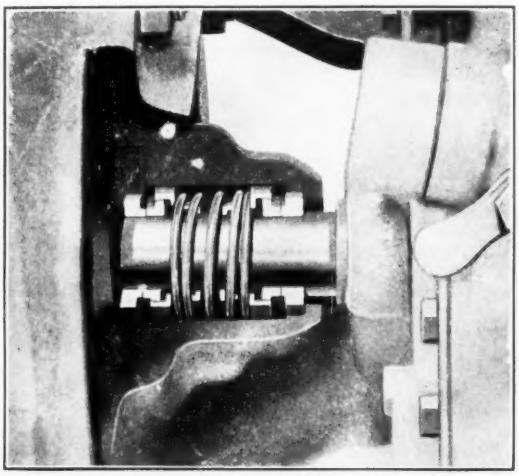
The steam engine must be lubricated according to the nature of the steam used. Pressure, temperature and moisture content are the controlling factors. Steam pressures will normally range in the neighborhood of 150 to 225 pounds per square inch. Steam temperatures, however, may approach 750 degrees Fahr. according to the amount of superheat. The moisture content will depend on the service.

In steam-shovel or locomotive crane operation there will usually be considerable condensation. This can be partially counteracted by taking steam from the highest part of the boiler and generous use of insulating pipe covering. Even with these precautions the steam, as delivered to the engine, is often relatively wet.

Regardless of the initial characteristics of the steam, cylinder condensation will occur where engines operate intermittently. Accordingly, water accumulation can be expected above the throttle valves prior to starting the engines, the amount depending upon the length of time the engines have been idle. If the cylinders are not adequately lubricated these slugs of water may wash the oil from the contact surfaces, and for the next few strokes insufficient lubrication will be probable and scoring and abnormal wear may develop. If this occurs continually it will not take long to produce compression losses and inefficient operation due to steam leakage past the piston rings. Lack of lubrication or wear will be indicated by periodic groaning of the engines or rattling of the valves on their seats. This will decrease the power available and lead to increased fuel consumption.

Type of Oil

A suitable cylinder oil should contain sufficient compound or animal fat to form a tenacious lubricating film and should be of adequate viscosity to withstand the prevailing cylinder temperatures. Oils of approximately 130 to 190 seconds Saybolt Universal viscosity at 210 degrees Fahr. will normally meet the requirements. The formation of a sufficient film to resist the washing action of any water that may be present is controlled by the amount of fatty compound used. For saturated steam conditions an oil containing 8 to 10 per cent. compound should be used. For superheated steam, around 3 to 5% compound will suffice.



Courtesy of Chain Belt Company

Fig. 11—The rotary seal on the Rex speed prime pump for mine dewatering is an important factor in assuring positive lubrication.

CONCLUSION

It is with considerable satisfaction that we review lubrication-maintenance of the power shovel and other machinery which is so necessary to getting out the iron-ore required for the war effort. If, at the same time, we have stressed sufficiently that lubrication is a most important factor in keeping essential steel off the scrap pile—so much the better. This year will see new records in steel production, planes, ships, tanks and other war material. It will require new records in earth moving and ore handling, but they will be unsung records. To make these records, the shovel runner must concentrate his efforts and attention on maintenance as actively as does the tank mechanic in the battle zone.

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Rock Products Machinery	August, 1941
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